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Assessment of Environmental Pollution Load of Transit Corridor in India

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1 ABSTRACT

In India, Transit Corridor development is an integral part of planning. India has an extensive transit network of 3.6 million km - the second largest in the world. The Government of India (GOI) launched a radical program in the late 1990s to upgrade three key national transit corridors: (i) the Golden Quadrilateral; (ii) the East-West Corridor; and (iii) the North-South Corridor, covering about 13,000 kilometers. The National Highways Authority of India (NHAI) was mandated with the responsibility of carrying out this National Highways Development Program (NHDP) in 2000s. In post NHDP Phase III programme a massive programe was involving of upgradation of about 10,417 km of national highways. This programme was an addition to the onging NHDP and includes upgrading linkages to the NHDP corridors. This programme involved four or six laning of existing two lane national highways of most of the selected national highways over 29 states and 7 union territories in India. The criteria for selection of the project roads are corridor with high density traffic which has avaergae daily traffic of more than 30,000 passenger car equivalent units, carridor providing state capitals with links to the NHDP network and corridor providing access to economic and tourist centres.

The number of vehicles on roads has been growing at compounded annual growth rate (CAGR) of approximately 8 percent in the last five years. The growth rate of vehicles is the backbone of economic development and the Indian automotive Industry is the second fastest growing in the world. About 8 million vehicles are produced annually in the country today. In 2009, the country reported 121.63 million registered motor vehicles, a motorization rate of 22 vehicles per 1000 population (Road Transport Yearbook, 2008. Motor vehicle growth rate has been largely concentrated in the major cities. India has experienced tremendous growth rate in motor vehicles & this lead to interest of environmentalist, business leaders, government officials and researchers for a number of reasons. Already, India’s motor vehicles have had a substantial detrimental impact on the environment. Automobiles are the primary sources of air pollution in India’s major cities. In India, transport sector emits an estimated 261 Tg of CO2, of which 94.5 % was contributed by road transport. The transport sector in India consumes about 17 % of total energy & is responsible for 60% of the Green House gas from various activities (Tedoy, 2008). The pollution from vehicles is due to discharge like CO, unburnt HC, Pb, NO2 & suspended particulate matter mainly from tail pipes.

The potential massive size of the nation’s motor vehicle fleet has raised concern over the addition of carbon dioxide to the atmosphere & its potential for global change. An examination of the factors that have contributed to rapid growth rate of motor vehicle in India is very important to understand the likely future course that the growth might take. Central Pollution Control Board, India is executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of three hundred and forty two (342) operating stations covering one hundred and twenty seven (127) cities/towns in twenty six (26) states and four (4) Union Territories of the country. All receptors are not being monitored all along national highways. There is huge gap in database preparation, monitoring and analysis.

This paper apraises the alignments of national highways all over Country with traffic density and available databse of pollution load. The overall anlayis gives the national wide framework of pollution load all along the transit corridor as baseline anlsysis for future planning.

Keywords: NAMP, transit corridor, NHDP, environmental pollution load, planning

2 INTRODUCTION

Transport is essentially a derived demand depending upon the size and structure of the economy and the demographic profile of the population. Road transport is vital to the economic development and social integration of the India. Easy accessibility, flexibility of operations, door-to-door service and reliability have earned road transport an increasingly higher share of both passenger and freight traffic vis-à-vis other transport modes. Greater the share of commodity-producing sectors like agriculture and manufacturing, higher is the demand for transport. From 1951 at 0.399 million km to 4.110 million km as on 2008 the total road length in India has increased. Concurrently, the surfaced road had increased over the same period from 1.57 lakh km to around 20.36 lakh km. Since 1970s the total road length had expanded significantly. It has increased from 0.915 million km in March 1971 to 4.110 million km in March 2008 – with an increase rate of 34.9 percent over these 37 years as compound annual growth rate (CAGR) of 4.1 percent. During this period category wise classification of road length showed that the length of National transit Corridor i.e. National Highways (NHs) increased from 23,838 km to 70,934 km – an increase of over 180 percent or CAGR of 2.8 percent. It is notable that the 'National Highways' registered an increase of 14,744 km (from 52,010 km in 2000 to 70,934 km in March 2010) over a period of 10 years. Arterial roads of the country for inter-state movements of passengers and goods are National Highways. NHs traverses the length and width of the country connecting the National and State capitals, major ports and rail junctions and link up with border roads and foreign highways.

India has an extensive transit network of 3.6 million km - the second largest in the world. The Government of India (GOI) launched a radical program in the late 1990s to upgrade three key national transit corridors: (i) the Golden Quadrilateral; (ii) the East-West Corridor; and (iii) the North-South Corridor, covering about 13,000 kilometers. The National Highways Authority of India (NHAI) was mandated with the responsibility of carrying out this National Highways Development Program (NHDP) in 2000s. In post NHDP Phase III programme a massive programe was involving of upgradation of about 10,417 km of national highways. This programme was an addition to the onging NHDP and includes upgrading linkages to the NHDP corridors. This programme involved four or six laning of existing two lane national highways of most of the selected national highways over 29 states and 7 union territories in India. The criteria for selection of the project roads are corridor with high density traffic which has avaergae daily traffic of more than 30,000 passenger car equivalent units, carridor providing state capitals with links to the NHDP network and corridor providing access to economic and tourist centres.

3 GROWTH OF TRANSIT CORRIDOR

Growing demand in transport India has been rapidly increase. Road transport has grown inter-state freight and passenger movement compared to railways, inland waterways and air because it does not face rigorous en-route checks/barriers. In policy planning and investment decisions transit corridor has to have comprehensive data for analyse further. It is a systematic numbering scheme based on the orientation and the geographic location of the highway. This was adopted to ensure more flexibility and consistency in the numbering of existing and new national highways.

As per the new numbering system:

All north-south oriented highways will have even numbers increasing from the east to the west

All east-west oriented highways will have odd numbers increasing from the north to the south

All major Highways will be single digit or double digit in number

Three digit numbered highways are secondary routes or branches of a main highway. The secondary route number is prefixed to the number of the main highway. For example, 144, 244, 344 etc. will be the branches of the main NH44.

Suffixes A, B, C, D etc. are added to the three digit sub highways to indicate very small spin-offs or stretches of sub-highways.

The network of National Highway of the country spans about 70,934 km. The National Highway Development Project (NHDP) covers a length of about 54,000 km of highways which is India's largest road development programme in its record. Out of total 6 lane toad has 731 km in length, 4 lane road aligns 14,584 km in length, 2 lane road is about 37,488 km and rest is single or intermediate lane. There are total 212 National Higheways are aligned all over in India's teriitory. Out of 35 states and UTs the maxium length is found in state Andhra Pradesh followed by North east state arunachal Pradesh. The length of transit corridor over india's state is tabulated as under. (Table 1)

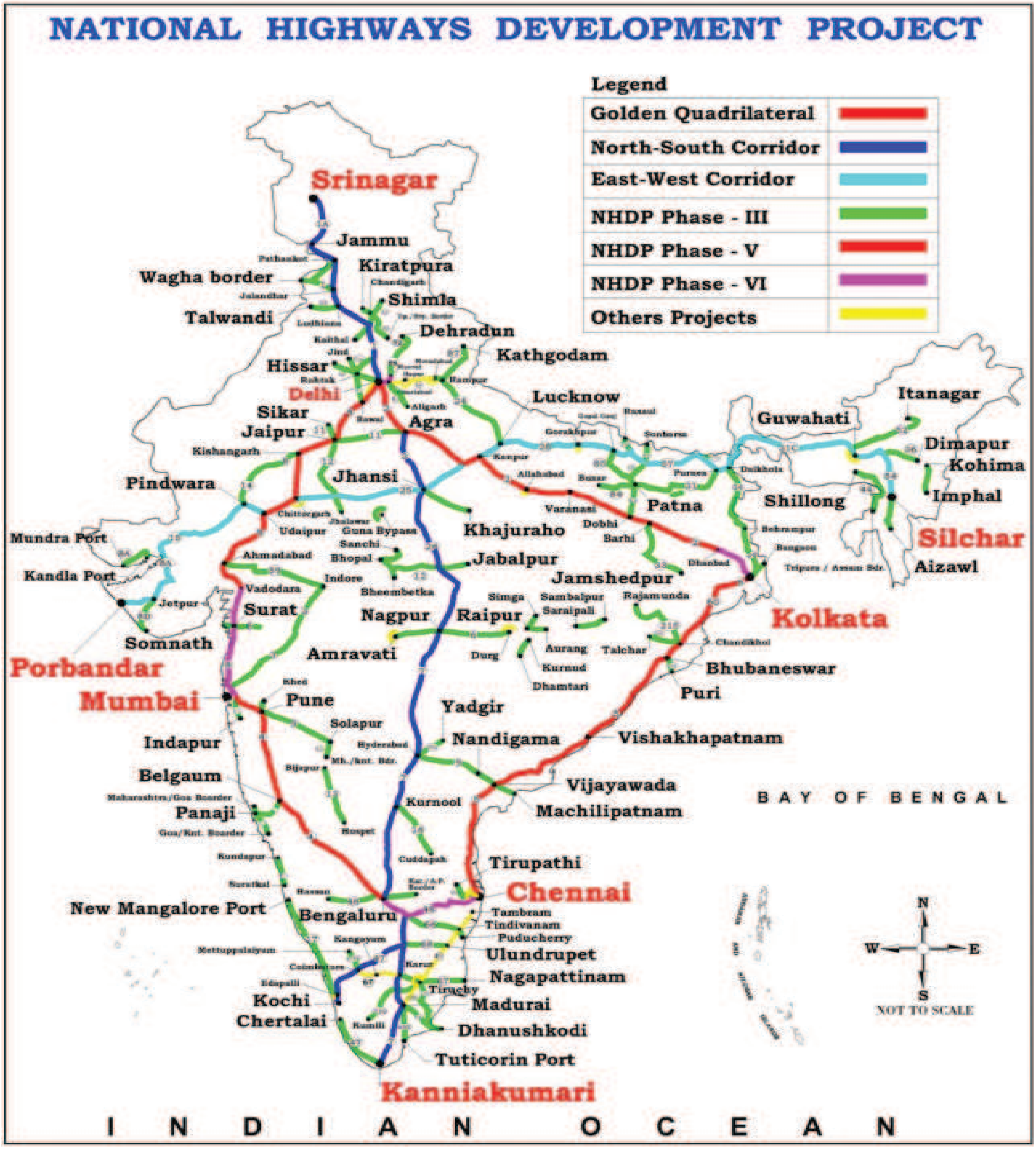

Fig 1: Transit Corridor in India. Source: NHAI, 2012

During the period 2000 to 2008, National Highways extended upto 28 percent. Out of total length (66,754 km) of National Highways 27 percent is of single lane/intermediate lane, 58 percent is 2-lane standard and balance of 15 percent is 4-lane standard or more. Government of India has conceptualized huge investment under construction and upgradation of National Highways under various phases of NHDP. NHDP Phase-I: In December 2000 this phase was approved. It envisaged - (a) Four laning of National Highways comprising Golden Quadrilateral (GQ) linking major metros, viz. Delhi, Mumbai, Chennai and Kolkata having an aggregate length of 5846 km; (b) North-South and East-West corridors covering 981 km; (c) Port connectivity by upgrading 356 km of NHs linking major ports in the country and; (d) upgradation of 315 km of other National Highways. The total aggregate length of NHs for upgradation calculated under Phase I was placed at 7498 km. The total length completed upto 31st March 2010 was 7328 km. NHDP Phase-II: In December 2003 this phase was approved. The main thrust of this phase involved upgradation (4 laning) of (a) North-South (Srinagar to Kanyakumari) and East-West (Silchar to Porbandar) corridors covering a distance of 6161 km and; (b) upgradation of 486 km stretch of other National Highways. The total length coverage for upgradation under Phase - II involved 6647 km out of which 4465 km has been completed by 31st March 2010. NHDP Phase-III: NHDP Phase-III involves 4-laning of 12,109 km with high-density stretches of NHs joining State capitals, important tourist places and of economic importance locations through Public Private Partnership (PPP). Out of this, implementation of 4815 km on BOT was approved under NHDP Phase IIIA. NHDP Phase IIIB involving implementation of the balance 7294 km was approved in April 2007. Till 31st March 2010, 1581 km of road length had been completed. NHDP Phase-IV: This phase involved improvement of 20,000 km of NHs to two lanes with paved shoulders. NHDP Phase-V: This phase was approved for six laning of 6,500 km of existing 4 lane highways in October 2006 on Design Build Finance and Operation (DBFO) basis. This included 5,700 km of GQ and 800 km of other selected stretches. NHDP Phase-VI: This phase, approved in November 2006, envisaged development of 1000 km of access controlled four/six lane divided carriageway expressways on DBFO basis.NHDP Phase-VII: This phase was approved in December 2007 for construction of stand alone ring roads, by-passes (including improvements of NH links in city), Grade Separated Intersections, flyovers, elevated highways, Road Over Bridges (ROBs), underpasses and service roads on BOT Toll basis.

Name of the State /Union Territory	Length (Kms)	Name of the State/ Union Territory	Length (Kms)
Andhra Pradesh	5231.74	Manipur	1745.74
Arunachal Pradesh	2513.05	Meghalaya	1204.36
Assam	3811.67	Mizoram	1381
Bihar	4678.79	Nagaland	1150.09
Chandigarh	15.28	Orissa	4644.52
Chhatisgarh	3078.4	Pondicherry	64.03
Delhi	80	Punjab	2769.15
Goa	262	Rajasthan	7906.2
Gujarat	4970.9	Sikkim	309
Haryana	2622.48	Tamil Nadu	5006.14
Himachal Pradesh	2622.48	Tripura	577
Jammu & Kashmir	2593	Telangana	2635.84
Jharkhand	2653.64	Uttar Pradesh	8483
Karnataka	6502.29	Uttarakhand	2841.92
Kerala	1811.52	West Bengal	2909.8
Madhya Pradesh	5193.57	Andaman & Nicobar	330.7
Dadra Nagar Haveli	31	Daman & Diu	22
Maharashtra	7434.79		

Table 1: State wise distribution of National Transit Corridor

4 GROWTH OF MOTOR VEHICLE

The growth rate of vehicles is the backbone of economic development of Indian automotive Industry, which is the second fastest growing in the world. About 8 million vehicles are produced annually in the country today. In 2009, the country reported 121.63 million registered motor vehicles, a motorization rate of 22 vehicles per 1000 population (Road Transport Yearbook, 2008). Over the last three decades, motor vehicles numbers have been doubling every ten or fewer years in India as against a 2 % - 5 % annual growth rate in Canada, the United States, the United Kingdom & Japan (Badami, 2009). The total number of motor vehicles increased from 52.37 million in 2000 to 121.63 million in 2009 i.e. an average growth rate of 9 % per year in the country. Some analysts predicted that India's motorization rate will continue to grow to 40 vehicles per 1000 by 2020. The largest majority of vehicles in India are found in metro cities. Number of vehicles in Indian cities is 40 millions with a share 30 % of total vehicles in India. Chennai, Bangalore, Kolkatta, Delhi and Mumbai with 15.2 million vehicles constitute 38 % of total vehicles of important cites and 13 % of total vehicles in India (Motor Transport Statistics, 2009). The second tier cities like Coimbtore (12 %), Madurai (11 %), Nagpur (14.6 %) and Vishakhapatnam (17.2 %) posted a compound annual growth rate (CAGR) of about 11 % or more. The growth of vehicular traffic on roads has been far greater than the growth of the highways; as a result the main arteries face capacity saturation. Between 1951 and 2002 the vehicle population grew at a compound annual growth rate (CAGR) of close to 11 per cent compared to CAGR of 4.3 per cent in the total road length with National Highway segment increasing by a mere 2.1 per cent. A noteworthy aspect has been a step-up in the growth of national highway network in recent years which has grown at CAGR of more than 5 per cent with total vehicle population growing at close to 10 per cent CAGR during 1991-2004. (Table 2)

Period	Vehicle					Roads				
	Two Wheeler	Cars	HVs	Others	Total	National Highways	State Highways & Public Works Deptt	Rural	Project	Total
1951-2002	15.5	7.9	7.0	15.5	10.9	2.1	0.02	4.5	-	4.3
1951-61	12.5	6.9	6.8	26.5	8.1	1.9	4.0	-0.5	-	2.7
1961-71	20.7	8.2	6.9	15.0	10.9	0.0	2.6	6.0	415.9	5.7
1971-81	16.3	5.5	5.1	18.1	11.2	2.9	-11.9	11.5	4.3	5.0
1981-91	18.4	9.8	8.9	10.9	14.8	0.6	21.0	1.9	2.5	4.6
1991-2001	10.3	9.0	7.2	8.4	9.7	5.1	2.8	4.2	1.7	3.4
1991-2004	10.5	9.4	7.9	7.9	9.9					

Table 2: Compund Annual Growth Rate 9in%) in Vehicles and Road Length. Source: 11th FYP, Planning Commission Report

Composition of vehicle population in India in the year 2004, the latest year for which the data is available, reveals preponderance of two-wheelers with a share of more than 71 per cent in total vehicle population, followed by cars with 13 per cent and other vehicles (a heterogeneous category which includes 3 wheelers, trailers, tractors etc.) with 9.4 per cent. However, the share of buses and trucks in the vehicle population at 1 per cent and 5 per cent respectively is much lower compared to China. With a rising income and inadequate urban public transport system, in particular, the personalized mode of transport is likely to grow in importance in the coming years. Presently the share of cars in the total vehicle population in India is much lower in comparison to Sri Lanka, Malaysia and Chile but equivalent to China.

Motor vehicle fleet in whole country composed of two-wheelers, three wheeler (car, jeep and taxi), passenger vehicle (Bus and other passenger vehicle) and commercial vehicle. India had 121.63 million vehicles at the end of year 2009. Personalized mode (constituting mainly two wheeler and cars) accounted for more than four-fifth of motor vehicles in the country compared to their share of little three-fifth in 1951. Further breakup of motor vehicle population reflects preponderance of two wheeler with share of more than 73 % in total vehicle population followed by three wheeler (Car and Jeep) at 15 % and passenger vehicles at 10 % (See Table 3). Share of commercial vehicle is very low, near about 5 %. With a rising income and greater need for mobility the personalized mode of transport is likely to grow in importance in coming year. India like many other countries in Asia has experienced high annual growth rate in excess of 10 %. This is equivalent to doubling vehicle fleet in about seven years. The two wheeler population in India is 3856 Crores in 2001 which increase upto 91235 crores in 2009 almost tripled in 9 years. With the rapid pace of urbanization and economic development, more is a rising trends of personal vehicles. Car is most comfortable vehicle and luxurious option for transportation in India. So share of car is rising in Indiaand accounts 9 %. The car owner ship in India is 8 per thousand people (Burange & Yamini, 2010). With country's highway infrastructure improving and business growing, growth of small and heavy commercial vehicles segment outperforming in the growth. The commercial vehicle population doubled of in last ten years. The growth rates of commercial vehicle remain same in all the years and steadily rising.

Years	Two wheelers (In Crores)	Three Wheelers (In Crores)	Passenger Vehicle (In Crores)	Commercial Vehicle (In Crores)
2001	38556	7058	6429	2948
2002	41581	7613	6756	2973
2003	47519	8599	7397	3492
2004	51922	9451	7596	3749
2005	58799	10320	8349	4031
2006	64743	11526	8913	4436
2007	73209	11860	9080	4985
2008	81235	12023	10263	5401
2009	91235	12523	10500	5967

Table 3: Composition of Indian Motor Vehicle Population, 2000-2009. Source: Ministry of Surface Transport of India, Society for Automobile Association of India.

Government policy can have a significant impact on the size, composition and growth rate of a nation's motor vehicle fleet. In India, state and national governments directly or indirectly control the supply, demand, the distribution of automobiles, fuel price and fuel supply, the development of road and other component of infrastructure needed to motor vehicles. In India, state also directly involve in the development of public transport system (The Energy Resource Institute, TERI, 2009). Healthy competition benefited the end consumer since cost of service or product come down substantially, added many consumer dreaming of an own vehicle. So number of privately vehicles has grown substantially in last 10 years. Car ownership is growing at a rate of 10-15% per year (Tiwari, 2007). The growth rate of motorcycle is 17.4 % during last 6 year and overall penetration of two-wheeler in India become 28 % of all household (Indicus, 2010). Secondly, large investments have been made for the development of transport infrastructure and facilities. There has also been impressive qualitative development by state government also. Private participation is made for development of highway, service centre and maintenance of road etc. This promotes better quality services to transport and have a positive impact on the growth rate of private vehicle. Private vehicle accounts for 30 % of total transport in India (Tiwari, 2007).

5 ASSESSMENT OF POLLUTION LOAD ON TRANSIT CORRIDOR

Recently, some scientists and environmentalists have directly challenged government policy to develop a western style automobile centered transportation system. They pointed that automobile will increase traffic congestion and worsen air pollution. So policy maker should concern about problem associated with development of motorized India (Vinish, 2008). The total consumption of petroleum products grew at the rate of 5.7% per annum between 1980-81 and 2003-04. However, growth in consumption has moderated to 2.95% per annum over the four years (2000-01 to 2004-05). Consumption of petrol and diesel grew at 7.3% and 5.8% per annum respectively between 1980-81 and 2004-05. This was the outcome of the growth of personal motorized transport and the rise in share of road haulage. The vehicle population continues to grow at higher than historical rates. However, in the last 5 years growth in consumption of petrol and diesel has been far more moderate at 6.9% and less than 1% respectively. This reflects the improved efficiency of vehicles and better road conditions. In 2004-05, liquid fuel consumption in the transport sector accounted for 28% of our total petroleum products consumption (Source: Integrated Energy Policy, Planning Commission 2006; Page 10).

5.1 Ambient Air Quality Pollution Load Assessment

Emission from the road transport sector depends mainly on the fuel. Apart from type of combustion engine, emission mitigation techniques, maintenance procedures and vehicle age Diesel is used as fuel in public transport and in cargo vehicles, cars and jeeps, used as gasoline. The major pollutants emitted from road transport are CO_2, CO, NOx, N_2O, SO_2, VOC, PM, and HC. Emission from road traffic was estimated based on the number of vehicles and distance travelled in a year per different types of vehicle. This is given in following equation.

$$E_i = \Sigma (V_j * D_j) * E_{ij,km}$$

Where E_i =Emission of compound (i)

V_j = Number of vehicle/type (j)

D_j = Distance traveled in a year per different vehicle type (j)

$E_{ij,km}$ = Emission of compound (i) from vehicle type (j) per driven km.

It is not always feasible and economical to carry out air pollution monitoring to measures the pollutants concentration at all sensitive receptors along the road corridor. To minimize the time and monetary cost, vehicular pollution dispersion modelling is an important aid to predict present as well as future pollutants concentrations along the long stretches of road corridors to facilitate the abatement and management of vehicular/ urban air pollution. They are used to simulate the dispersion of vehicular pollutants near roads where vehicles continuously emit pollutants. CALINE-4 the latest in CALINE series models is most widely used. Gaussian based vehicular pollution dispersion model has predict air pollutants concentrations.

CALINE–4, dispersion model is for prediction of concentrations of critical atmospheric pollutants (CO, NOx, SO_2, SPM and PM10) along the highways. This model employs a mixing zone concept to characterise pollutant dispersion over the highway and can be used to predict the pollutant concentrations for receptors upto 500 m of the corridor. The various input parameters for the prediction of pollutant concentrations are discussed here:

(a) Site Geometry: The input parameters regarding the site conditions as the carriageway width, road height, mixing zone width, surface roughness and topographic conditions have been taken up from the pavement condition and road inventory surveys conducted along the project corridor.

(b) Emission factors: The emission factors for the various vehicle categories vary for different speeds. The emission factors adopted for the various vehicle speeds for the various pollutants are given in the following table.

Pollutant Parameter	Emission factors g/mile		
	Light	Medium	Heavy
	(Irrespective of speed)		60 Kmph
SO2	13.97	7.70	6.95
SPM/ PM^{10}	2.86	0.60	0.22
NOx	14.28	2.48	8.94

Table 4: Speed Corrected Emission factors. Source: Vehicle Emissions and Control Perspective in India, IIP, Dehradun.

Based on the traffic composition, a composite emission factor has been derived for application in the model for the various sensitive receptors and links. The composite emission factor has been derived as a sum of the ratio of light, medium and heavy vehicles to the total volume and their corresponding emission factors.

(c) Meteorological Conditions: The various meteorological input parameters required for modeling as the wind speed, wind direction, mixing height, stability class have been collected from secondary sources as Indian Metrological Department (IMD), for the nearest meteorological stations.

(d) Traffic volume: The through traffic volume and composition along the sensitive receptors have been derived from the traffic volume counts carried out at various locations along the project corridor.

(e) Links: Links are homogenous sections of the project corridor, of length not greater than 10 km, with similar traffic, site geometrics and meteorological characteristics. For calculating the emissions, worst-case scenario is assumed and concentrations are obtained for worst wind direction.

(f) Receptors: Receptors are specific locations within a link, which is likely to be impacted by vehicular emissions. For the purposes of assessing air impacts, sensitive receptors have been identified over an immediate influence area on either side of the project corridor.

(g) The concentrations of the various pollutants due to the project have been estimated applying the various input parameters to the CALINE 4 model.

Predicted Pollution levels:

Various assumptions made for predicting the pollution levels along the corridor through this model are discussed here. No significant change in emission characteristics of the vehicles is anticipated during the different last 5 years and any assumption in decrease of emission factors would only be hypothetical. This assumption would give a conservative estimate of the emissions and any decrease in emissions in future than those used for prediction will be beneficial. There are no major grade differences in the Transit Corridor as it is generally a plain and gentle slopes and the model is applied for "At grade" condition for the whole corridor assumed. The traffic along the national highways state wise is assumed to flow simultaneously in both the lanes and in both directions. This assumption presents a worst-case scenario of the pollution levels. Data have been refereed from different secondary sources and Caline 4 model has been attempted to assess the present level pollution load of Natitional Transit corridor in state wise in cumulative form as under.

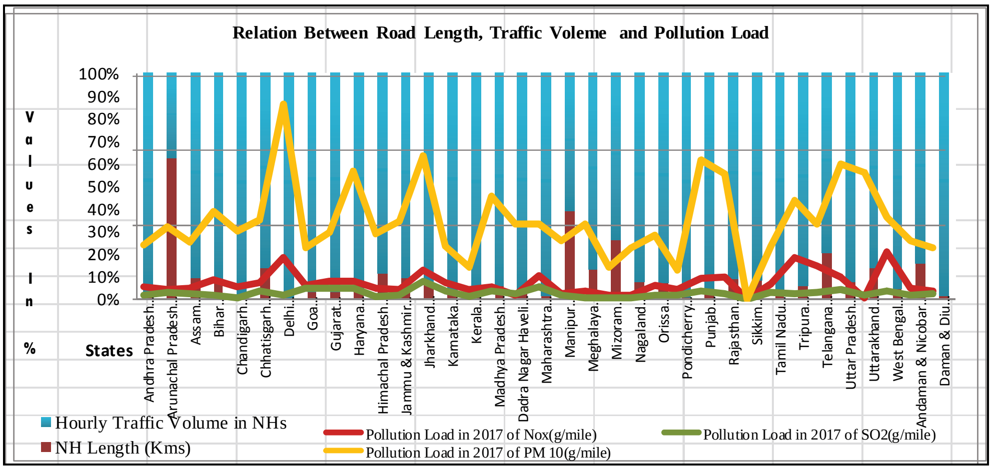

Fig. 2: Relation between road length, traffic volume and pollution load.

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State wise distribution of National Highways in 2011 & Estimated Traffic Volume in 2017							**Composite Emission Factor for year 2017**			**Caline 4 Modeling : Hourly Air Quality Assessment**		
Sr. No.	**Name of the State /Union Territory**	**NH Length (Kms)**	**Light Vehicle**	**Medium Vehicle**	**Heavy Vehicle**	**Hourly Traffic Volume in NHs**	**EF for Nox (g/km)**	**EF for SO2 (g/km)**	**EF for PM 10 (g/km)**	**Pollution Load in 2017 of Nox(g/km)**	**Pollution Load in 2017 of SO2(g/km)**	**Pollution Load in 2017 of PM 10 (g/km)**
1)	Andhra Pradesh	5231.74	211688	62531	110110	274232	1	12	0.05	18	6	74
2)	Arunachal Pradesh	2513.05	1128	375	1670	1503	21	5	4.25	13	9	97
3)	Assam	3811.67	29852	6969	69689	36829	5	18	0.29	16	8	77
4)	Bihar	4678.79	24951	39993	8894	64944	2	8	0.11	27	6	119
5)	Chandigarh	15.28	5521	974	2240	6496	1	13	0.01	17	3	93
6)	Chhatisgarh	3078.4	17080	2770	16569	19851	3	16	0.42	23	12	108
7)	Delhi	80	89811	8563	46005	98379	1	13	0.00	56	6	262
8)	Goa	262	2451	5149	21853	7602	18	16	0.07	19	15	69
9)	Gujarat	4970.9	139337	26353	142344	165706	2	14	0.08	24	16	90
10)	Haryana	2622.48	66194	8989	107818	75195	2	15	0.10	24	15	172
11)	Himachal Pradesh	2622.48	12896	7998	21264	20897	5	16	0.28	16	4	89
12)	Jammu & Kashmir	2593	18019	7511	30035	25533	5	16	0.25	14	6	106
13)	Jharkhand	2653.64	25759	13581	43534	39345	5	15	0.16	40	24	194
14)	Karnataka	6502.29	153616	37062	138188	190694	2	14	0.09	23	11	71
15)	Kerala	1811.52	188390	65864	847006	254351	8	22	0.02	14	5	43
16)	Madhya Pradesh	5193.57	50046	40018	61210	90071	4	12	0.12	18	12	138
17)	Dadra Nagar Haveli	31	1259	68	3436	1327	2	16	0.08	6	8	102
18)	Maharashtra	7434.79	478102	67314	194691	545438	1	13	0.04	32	18	102
19)	Manipur	1745.74	2516	207	5124	2724	10	20	1.99	8	6	79
20)	Meghalaya	1204.36	3374	4638	11306	8013	9	16	0.28	11	3	102
21)	Mizoram	1381	1119	2743	2848	3862	7	15	0.51	7	3	43
22)	Nagaland	1150.09	11744	2752	28132	14499	5	18	0.23	7	3	69
23)	Orissa	4644.52	45212	16734	49735	61952	3	15	0.18	19	6	87
24)	Pondicherry	64.03	4231	2254	7641	6486	4	14	0.02	14	7	39
25)	Punjab	2769.15	56565	5465	49110	62036	1	14	0.13	28	12	188
26)	Rajasthan	7906.2	56398	23473	147048	79888	6	19	0.26	30	8	169
27)	Sikkim	309	269	3329	1254	3598	3	2	0.07	1	1	1
28)	Tamil Nadu	5006.14	223375	74019	223055	297420	2	13	0.04	21	10	71
29)	Tripura	577	8675	724	5553	9399	1	14	0.17	56	8	133
30)	Telangana	2635.84	4656	5436	8945	10093	7	17	0.48	45	9	102
31)	Uttar Pradesh	8483	92963	15644	73320	108615	2	14	0.21	31	13	182
32)	Uttarakhand	2841.92	8933	8838	9923	17772	4	14	0.30	3	6	170
33)	West Bengal	2909.8	22173	37909	153377	60100	15	17	0.10	65	11	111
34)	Andaman & Nicobar	330.7	1690	135	1306	1826	3	15	0.52	16	7	79
35)	Daman & Diu	22	1811	24	1454	1834	0	14	0.04	12	8	70

Source: Planning Commission Report 2012 & NAAQS, CPCB, 2010

Table 5: Assessment of Pollution Load in Transit Coridor in India, 2017

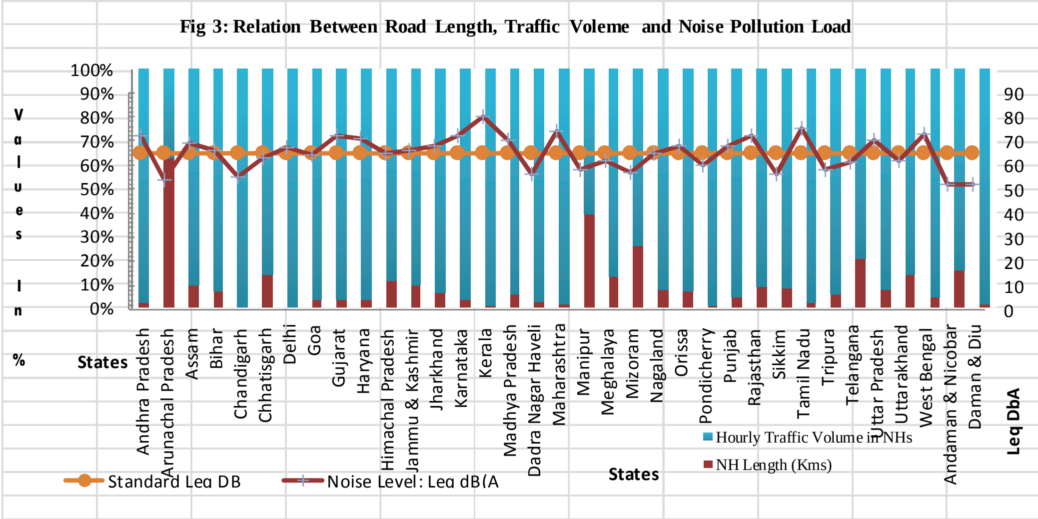

Fig. 3: Relation between road length, traffic volume and noise pollution load.

From above table it depicts the maximum traffic volume emits maximum pollution. Those states have maximum number of vehicle in transit corridor have maxium pollution load in terms of Partculate Matters (PM10 g/km). Even ratio of road length to volume of traffic is also positively coreraled. Major city has more number of vehicular traffic counted in states compared to states located in north east or small states. The maxium vehicular traffic is marked in Mjhrashtra, Delhi, Punjab, Uttar Preadsh, Andhra Pradesh,

Maharashtra, Chandigarh. The maximum road length under National Highway is Rajasthan, Karnataka, Tamil Nadu etc. Most preferable condition compared to road length and traffic volumes are in North Eastern States and Union Territories. The following diagramme shows the concentration of ambient air quality in different states with comparison of Traffic volume and length of National Highways. More favourable condition lies to north eastern states and Union Territories but big states with high density traffic volume genertates more emission.

5.2 Ambient Noise Pollution Assessment

Noise impacts can be predicted at various receptors by application of available simulation models for Highway noise. However, this is applicable only for operation stage of the project. Operational noise for the highway is predicted through the model developed by Federal Highway dministration, Department of Transportation of the U.S. The model used is FHWA Noise Model. The procedure for prediction of noise levels involves the following steps:

Input Parameters: Traffic volume & Speed: Traffic volume for the projected period is obtained from the traffic projections. The total number of vehicles passing per hour by type - light, medium and heavy along with their average speed is used for projections.

Mean Energy level: All the vehicles produce noise, which is taken as the base, and the cumulative noise at the receptor distance due to the whole traffic is estimated. The mean energy level varies depending on the type of vehicle. A mean energy level for the light, medium vehicles is 70 dB and for heavy vehicles it is 80 dB.

Shielding & Absorption factors: This depends on the landuse prevailing along the corridor. The range of shielding provided for the noise and absorption of the noise is 3.5 to 4 and 0.3 to 0.5 respectively.

Application of Model: Equivalent noise levels due to traffic, at the receptor locations is estimated using Federal Highway Noise model,

$Leq(h)i = Loe + 10Log (Ni/SiT) + 10Log (15/d)1+b + Ds – 13$

Where,

$Leq(h)i$ = Equivalent noise level of ith vehicle (h indicates vehicle type- light, medium, heavy).

Loe = Reference mean energy level.

Ni = Number of class i vehicles passing during time T.

Si = Average speed for i th vehicle class in km/hr.

T = Duration for which Leq is desired corresponding to Ni.

d = Perpendicular distance in meters from the center line of the traffic lane to the receptor location.

b = Factor related to the absorption characteristics of the ground cover between the roadways and observer.

Ds = Shielding factor to account for the decrease in noise due to obstructions between source and receptor.

The preceding equation is used thrice, for light, medium and heavy vehicles respectively to obtain three values of Leq. The total Leq can be calculated by logarithmic addition of the three Leq values as follows,

Leq(Total) = 10 Leq (10 Leq(L)/10 + 10 Leq(M)/10 + 10 Leq(H)/10)

The total equivalent noise levels at the receptor, at a distance ‘d’ m from the center of the traffic lane is given by the above equation.

Predicted Noise Levels

Noise standards have been designated for different types of land use, i.e. residential, commercial, industrial and silence zones, as per ‘The Noise Pollution (Regulation and Control) Rules, 2009, Notified by the Ministry of Environment and Forests. Different standards have been stipulated during day time (6 am to 10 pm) and night time (10 pm to 6 am). The noise rating method as Leq i.e. equivalent sound pressure level has been adopted for the measurement of noise level. It is the energy means of the noise level over a specified period and is expressed in terms of decibels. State level noise analyses have been used for 2010 year database from secondary source. The predicted model for year 2017 shows that few states have noise level within the permissible range. But those states have high traffic volume have noise level is beyond permissioble limit.

6 CONCLUSIONS

India’s motor vehicles have had a substantial detrimental impact on the environment. Automobiles are the primary sources of air pollution in India’s major cities. In India, transport sector emits an estimated 261 Tg of pollution, of which 94.5 % was contributed by road transport. Analysis of database depicts the true picture of positive correlation between air pollution with traffic volume as well as Noise pollution with high density traffic in states. Staes level data has shown the basic. From the statistical descriptor values it was concluded that CALINE-4 model is predicting satisfactorily for air pollution under given traffic and meteorological and terrain condition/ national highways of states and Union Territories in India. Further Federal Highway Noise model also provides satisfactory result of noise level prediction of states in average value. The overall anlayis gives the national wide framework of pollution load all along the transit corridor as baseline anlsysis for future planning.